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# मानक

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IS 13585-3 (2013): Shunt Power Capacitors Of The Non -Self - Healing Type For ac Systems Having A Rated Voltage up to and Including 1 000 V, PART 3: Internal Fuses [ETD 29: Power Capacitors]



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भारतीय मानक

1 000 वॉट तक एवं सहित वोल्टता रेटिड धारक  
ए.सी. सिस्टम के नॉन-स्वतः रोपी टाइप के  
शंट पॉवर संधारित्र

भाग 3 आंतरिक फ्यूज़

*Indian Standard*

SHUNT POWER CAPACITORS OF THE  
NON-SELF-HEALING TYPE FOR a.c. SYSTEMS  
HAVING A RATED VOLTAGE UP TO AND  
INCLUDING 1 000 V

PART 3 INTERNAL FUSES

ICS 29.120.99;31.060.70

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**BUREAU OF INDIAN STANDARDS**  
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NEW DELHI 110002

## NATIONAL FOREWORD

This Indian Standard (Part 3) which is identical with IEC 60931-3 : 1996 'Shunt power capacitors of the non-self-healing type for a.c. systems having a rated voltage up to and including 1 000 V — Part 3: Internal fuses' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Power Capacitors Sectional Committee and approval of the Electrotechnical Division Council.

This standard is published in three parts. Other parts in this series are:

- Part 1 General — Performance, testing and rating — Safety requirements — Guide for installation and operation
- Part 2 Ageing test and destruction test

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

- a) Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'.
- b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appear to the following International Standard for which Indian Standard also exists. The corresponding Indian Standard, which is to be substituted in its place is listed below along with its degree of equivalence for the edition indicated:

| <i>International Standard</i>                                                                                                                                                                                                                               | <i>Corresponding Indian Standard</i>                                                                                                                                                                                                                                                      | <i>Degree of Equivalence</i>    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|
| IEC 60931-1 : 1989 Shunt power capacitors of the non-self-healing type for a.c. systems having a rated voltage up to and including 1 000 V — Part 1: General — Performance, testing and rating — Safety requirements — Guide for installation and operation | IS 13585 (Part 1) : 2012 Shunt power capacitors of the non-self-healing type for a.c. systems having a rated voltage up to and including 1 000 V: Part 1 General — Performance, testing and rating — Safety requirements — Guide for installation and operation ( <i>first revision</i> ) | Identical to IEC 60931-1 : 1996 |

Only the English language text has been retained while adopting it in this Indian Standard and as such the page numbers given here are not the same as in the IEC publication.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

SHUNT POWER CAPACITORS OF THE  
NON-SELF-HEALING TYPE FOR a.c. SYSTEMS  
HAVING A RATED VOLTAGE UP TO AND  
INCLUDING 1 000 V  
PART 3 INTERNAL FUSES

**1 Scope and object**

This part of IEC 931 applies to internal fuses which are designed to isolate faulty capacitor elements or a capacitor unit, in order to allow operation of the remaining parts of that capacitor unit and the bank in which the capacitor unit is connected. Such fuses are not a substitute for a switching device such as a circuit-breaker, or for external protection of the capacitor bank or any part thereof.

The object of this part of IEC 931 is to formulate requirements regarding performance and testing and to provide a guide for co-ordination of fuse protection.

**2 Normative reference**

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of IEC 931. At the time of publication, the edition indicated was valid. All normative documents are subject to revision, and parties to agreements based on this part of IEC 931 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 931-1: 1989, *Shunt power capacitors of the non-self-healing type for a.c. systems having a rated voltage up to and including 1 000 V – Part 1: General – Performance, testing and rating – Safety requirements – Guide for installation and operation*  
Amendment 1 (1991)

**3 Definitions**

For the purpose of this part of IEC 931, the definitions of IEC 931-1 apply.

**4 Performance requirements**

**4.1 General**

The fuse is connected in series to the element(s) which the fuse is intended to isolate if the element(s) becomes faulty. The range of currents and voltages for the fuse is therefore dependent on the capacitor design, and in some cases also on the bank in which the fuse is connected.

The requirements are valid for a bank or a capacitor switched by restrike-free circuit-breakers. If the circuit-breakers are not restrike-free, other requirements shall be agreed between manufacturer and purchaser.

The operation of an internal fuse is in general determined by one or both of the two following factors:

- the discharge energy from elements or units connected in parallel with the faulty element or unit;
- the power-frequency fault current.

#### *4.2 Disconnecting requirements*

The fuse shall enable the faulty element to be disconnected when electrical breakdown of elements occurs in a voltage range, in which  $u_1 = 0,9 \times \sqrt{2} U_N$  is the lowest, and  $u_2 = 1,5 \times \sqrt{2} U_N$  is the highest (instantaneous) value of the voltage between the terminals of the unit at the instant of fault.

The  $u_1$  and  $u_2$  values are based on the voltage that may normally occur across the capacitor unit terminals at the instant of electrical breakdown of the element.

The  $u_2$  value is of a transient nature and allowance has been made for damping.

If the purchaser specifies  $u_1$  and  $u_2$  values other than those indicated, for example for filter capacitors, the lower and upper test voltage limits shall be changed according to an agreement between manufacturer and purchaser.

#### *4.3 Withstand requirements*

4.3.1 After operation, the fuse assembly shall withstand full element voltage or full voltage between the terminals of the disconnected capacitor, plus any unbalance voltage due to fuse action, and any short-time transient overvoltages normally experienced during the life of the capacitor.

4.3.2 Throughout the life of the capacitor, the fuses shall be capable of carrying continuously a current equal to or greater than the maximum permissible unit current divided by the number of parallel fuses.

4.3.3 The fuses shall be capable of withstanding the inrush-currents due to the switching operations expected during the life of the capacitor.

4.3.4 The fuses connected to the undamaged elements shall be able to carry the discharge currents due to the breakdown of elements.

4.3.5 The fuses shall be able to carry the currents due to short-circuit faults on the bank external to the unit(s) occurring within the voltage range in accordance with 4.2.

### **5 Tests**

#### *5.1 Routine tests*

The fuses shall be able to withstand all routine tests of the capacitor unit in accordance with IEC 931-1.

## 5.2 *Type tests*

5.2.1 The fuses shall be able to withstand all type tests of the capacitor units in accordance with IEC 931-1 and IEC 931-2.

The unit(s) shall have passed all routine tests stated in IEC 931-1.

5.2.2 The disconnecting test on fuses (see 5.3) shall be performed either on one complete capacitor unit or, at the choice of the manufacturer, on two units, one unit being tested at the lower voltage limit, and one unit at the upper voltage limit, in accordance with 5.3.1.

NOTE – Due to testing, measuring and safety circumstances, it may be necessary to make some modifications to the unit(s) under test; for example those indicated in annex A. See also the different test methods given in annex A.

5.2.3 Type tests are considered valid if they are performed on capacitor(s) of a design identical with that of the capacitor offered, or on a capacitor(s) of a design that does not differ from it in any way that might affect the properties to be checked by the type tests.

## 5.3 *Disconnecting test on fuses*

### 5.3.1 *Test procedure*

The disconnecting test on fuses shall be performed at the lower voltage limit of  $0,9 \times U_N$  and at the upper voltage limit of  $1,6 \times U_N$ .

If the test is carried out with d.c., the test voltage shall be  $\sqrt{2}$  times the corresponding a.c. test voltage.

If the test is carried out with a.c., the triggering of the element failure with a voltage peak shall not be necessary for the test at the lower voltage limit.

Certain test methods are indicated in annex A.

### 5.3.2 *Capacitance measurement*

After the test, the capacitance shall be measured to prove that the fuses have blown. A measuring method shall be used that is sufficiently sensitive to detect the capacitance change caused by one blown fuse.

### 5.3.3 *Inspection of the unit*

Before opening, no significant deformation of the container shall be apparent.

After opening the container, a check shall be made to ensure that:

- a) no significant deformation of sound fuses is apparent;

b) no more than one additional fuse (or one-tenth of fused elements directly in parallel) has been damaged (see note 1 of clause A.1). If method b) given in annex A is used, note 1 of clause A.1 shall be observed.

NOTES

- 1 A small amount of blackening of the impregnant will not affect the quality of the capacitor.
- 2 Dangerous trapped charges may be present on elements disconnected either by operated fuses or by damage to their connections. All elements should be discharged with great care.

**5.3.4 Voltage test after opening the container**

A voltage test shall be carried out by applying a d.c. voltage of  $2,6 \times U_{Ne}$  ( $U_{Ne}$  element voltage) for 10 s across the broken-down element and the gap in its blown fuse. During the test, the gap shall be in the impregnant. No breakdown over the fuse gap is allowed.

NOTE – For units with all elements in parallel and for all units if test procedure b), c), d), or e) indicated in annex A is used, this test can be replaced by an a.c. test before the opening of the unit. The test voltage between the terminals is calculated using the capacitance ratio such that the voltage across the breakdown element and the gap in its blown fuse is  $2,6 \times U_{Ne} / \sqrt{2}$ .

**Annex A**  
(normative)

**Test procedures for the disconnecting test on internal fuses**

**A.1 General**

One of the test procedures a), b), c), d), e) or an alternative method, shall be used.

The capacitor voltage and current shall be recorded during the test to verify that the fuse has disconnected correctly. For d.c. testing, the test voltage shall be maintained at least 30 s after breakdown to ensure that the disconnection of the fuse is unaided by disconnection of the power supply.

To verify the current-limiting behaviour of the fuses when tested at the upper voltage limit, the voltage drop, excluding transient, across the blown fuse shall not exceed 30 %.

If the voltage drop exceeds 30 %, precaution shall be taken to make certain that the parallel stored energy and the power-frequency fault current available from the test system are representative of service conditions. A test shall then be made under these conditions to demonstrate satisfactory operation of the fuse.

NOTES

- 1 At the upper voltage limit, one additional fuse (or one-tenth of the fused elements directly in parallel) connected to a sound element(s) is allowed to be damaged.
- 2 Precautions should be taken when performing this test against the possible explosion of a capacitor unit and the explosive projection of the nail.

**A.2 Test procedure**

*a) Capacitor preheating*

The capacitor unit is preheated in a chamber before applying the a.c. test voltage at the lower voltage limit. Preheating temperature (100 °C to 150 °C) is chosen by the manufacturer to achieve a practical short time (some minutes to some hours) to the first breakdown.

NOTES

- 1 To prevent excessive internal liquid pressure due to high temperature, the unit may be equipped with a relief tube including a valve which is closed at the instant of applying the test voltage.
- 2 A lower preheating temperature may be used when applying the test voltage at the upper voltage limit, in order to avoid breakdowns before reaching the test voltage.

*b) Mechanical puncture of the element*

Mechanical puncture of the element is made by a nail, which is forced into the element through a pre-drilled hole in the container. The test voltage may be d.c. or a.c., the choice being left to the manufacturer.

If a.c. voltage is used, the timing of the puncture shall be made so that breakdown occurs close to the instant of peak voltage.

NOTES

- 1 Puncture of only one element cannot be guaranteed.
- 2 In order to limit the possibility of a flashover to the container along the nail, or through the hole caused by the nail, the punctures may be performed in the elements connected, permanently or during the test, to the container.
- 3 DC voltage is especially suitable for capacitors having all elements in parallel.

*c) Electrical breakdown of the element (first method)*

Some elements in the test unit are each provided with, for example, a tab inserted between the dielectric layers. Each tab is connected to a separate terminal.

The test voltage may be a.c. or d.c. the choice being left to the manufacturer.

To obtain breakdown of an element thus equipped, a surge voltage of sufficient amplitude is applied between this tab and one of the foils of the modified element.

In the case of a.c. voltage, the surge shall be triggered close to the instant of peak voltage.

*d) Electrical breakdown of the element (second method)*

Certain elements in the test unit are each provided with a short fusible wire connected to two extra tabs and inserted between the dielectric layers. Each tab is connected to a separate insulated terminal.

The test voltage may be d.c. or a.c., the choice being left to the manufacturer.

To obtain breakdown of an element equipped with this fusible wire, a separate capacitor charged to a sufficient voltage is discharged into the wire in order to blow it.

In the case of a.c. voltage, the discharge of the charged capacitor causing the wire to blow shall be triggered off close to the instant of the peak voltage.

*e) Electrical breakdown of the element (third method)*

A small part of an element (or of several elements) in a unit is removed at the time of manufacture and replaced with a weaker dielectric.

For example: 10 cm<sup>2</sup> to 20 cm<sup>2</sup> of a film-paper-film dielectric is cut out and replaced with two thin papers.

**Annex B**  
(informative)

**Guide for coordination of fuse protection**

**B.1 General**

The fuse is connected in series with the element that the fuse is designed to isolate if the element becomes faulty. After the breakdown of an element, the fuse connected to it will blow and isolate it from the remaining part of the capacitor, which allows the unit to continue in service. The blowing of one or more fuses will cause voltage changes within the bank.

The voltage across sound unit(s) should not exceed the value given in IEC 931-1.

Depending on the internal connection of the units, the blowing of one or more fuses may also cause a change of voltage within the unit.

The remaining elements in a series group will have an increased working voltage, and the manufacturer should, on request, give details of the voltage rise caused by blown fuses.

**B.2 Protection sequence**

The protection of a capacitor bank shall operate selectively.

The first step is the internal fuses of the elements.

The second step is the relay protection of the bank (e.g. overcurrent or unbalance protection).

The third step is network or plant protection.

NOTES

- 1 Depending on the output of the bank, the design of the relay protection etc., all three steps are not necessarily used in all capacitor banks.
  - 2 In large banks, an alarm stage may also be used.
  - 3 Unless the fuse always blows as a result of discharge energy within the voltage range given in 4.2, the manufacturer should provide the current/time characteristic and tolerance of the fuse.
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#### Amendments Issued Since Publication

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